

Materials Compatibility

Test methodologies for selecting materials to ensure long-term performance

We use materials compatibility tests to help ensure the stability and reliability of stockpile weapons over lifetimes of up to 30+ years. These tests are used for material selection to:

- Ensure that hazardous conditions are not created by the use of incompatible materials with chemical high explosives
- Ensure that performance is not degraded by interactions among construction materials
- Assess aging effects to determine realistic system lifetimes.

Screening methodology

The LLNL Chemical Reactivity Test (CRT) is used to evaluate the thermal stability and chemical compatibility of high explosives with other materials, although it has broad applicability. Essentially a thermal stability test, the CRT measures the gases evolved during exposure to a thermal environment (see figure). We also use materials coupon tests to screen candidate materials and interfaces. These tests are usually conducted at temperatures exceeding those expected in service, for periods of up to several months. The goal is to identify materials that

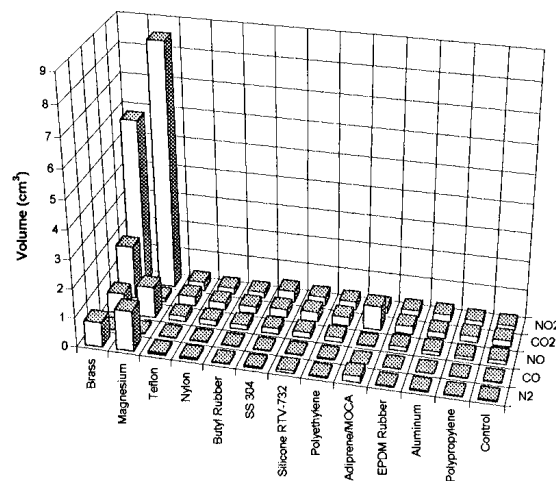
suffer a reduction in stability (chemical, physical, or mechanical), or show potential incompatibility with other materials.

Test protocols

In the development phase of a system, LLNL uses accelerated “core” tests. Cores are specially designed, small-scale

units that include all of the anticipated materials in a device and duplicate their various interfaces. Each material and component is subjected to the same final cleaning operations planned for use in production. Thus, the core test is the first compatibility test that addresses possible synergistic effects in a system.

To test aging, the core test units are subjected to a series of time-at-temperature sequences. Excessive accelerated aging temperatures are



Results of a CRT showing gas breakdown for different materials.

avoided to prevent the introduction of nonrepresentative aging and degradation mechanisms.

Once production starts, several actual assemblies are selected at random. These full-up units are instrumented and subjected to realistic aging conditions in a fashion similar to the core tests. The goal is to verify that all of the selected production materials and components retain their properties and functions.

Finally, a sampling plan is used to call back units from the field for disassembly and inspection to ensure that the system is aging as expected.

Availability: Available now. We are seeking collaborators interested in refining and extending our materials compatibility screening tests and assembly testing protocols. Products constructed of reactive materials that must perform as designed over long lifetimes could benefit from LLNL compatibility screening tests and protocols.

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APPLICATIONS

- Quick screening tests for evaluating thermal stability and chemical compatibility of materials
- Test protocols for accelerated aging of assemblies of materials